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Age-sex structure and reproductive capacity of the Pacific walrus population

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In the present walrus population, the recruitment based on the number of newborn amounts to 15—17%, and the recruitment based on the number of one-year-olds amounts to 11% of the total numbers of the population. The recruitment of the sexually mature part of the population is 9%. With the natural mortality taken into account, the increment in the walrus population does not exeed 3%. In the territorial waters of the USSR and USA, 2500—3000 walruses are killed annually; this number is slightly higher than the increment.

As a result of intensive exploitation of the walrus in the 19th and the first half of the 20th centuries, its numbers have greatly diminished everywhere. Judging from the literature (Fay, 1957; Scheffer, 1958; Mansfield, 1959; Fedoseyev, 1962, etc.), the numbers of the walrus throughout the Arctic today do not exceed 100,000 head. Despite the fact that commercial utilization of the walrus has been banned both in the USSR and abroad, the question of protecting and restoring the numbers of these animals is still a rather pressing one. The point is that the walrus is utilized by the local population, and it is impossible to stop this, since walrus meat is one of the staple foods of the Eskimo and coastal Chukchi in some places. Future utilization of the walrus should be carried out only on

the basis of biologically substantiated rates of harvesting. This calls for a detailed study of the population dynamics of this species.

This paper is an attempt to characterize the age—sex structure, reproductive capacity and differentiation of the Pacific walrus population (*Odobaenus rosmarus divergens* Illiger, 1815).

The paper is based on our own observations carried out at the ice rookeries and coastal hauling-out grounds of the walrus in the Bering and Chukchi seas, material on the age composition of walrus takes (teeth from 541 animals, collected in the autumn of 1964), as well as data from the literature.

Numerous researchers (Arsenyev, 1927; Belopolsky, 1939; Freiman, 1940; Nikulin, 1940; Yablokov, Belkovich, 1962; Krylov, 1965; Collins, 1940; Fay, 1957, etc.) have noted that the ice rookeries and coastal hauling-out grounds formed by the walruses during the summer—autumn differ in the composition of the animals. Two main types of groups are noted, namely mixed groups consisting of females with their pups and sexually immature individuals of both sexes, as well as male groups consisting exclusively of adult males. It has also been established that mainly male walruses are found in the Anadyr Gulf (Rudder, Meyechken hauling-out grounds) and on the northeastern shores of the Chukchi Peninsula during the summer. It has been noted that only adult males haul out at the Rudder grounds (Arsenyev, 1927; Nikulin, 1940; Yablokov, Belkovich, 1962, etc.). V.I. Krylov (1966) has established that along with the adult males, up to 8—10% of the herd at the Rudder grounds consists of juveniles up to 3 years of age. Some of the males migrate to the northwestern part of the Chukchi Sea (near Wrangel Is.), which is also inhabited by females with their pups and sexually immature individuals of both sexes.

Thanks to the method of age determination by tooth cement layers (Chapsky, 1941; Mansfield, 1959; Krylov, 1965, etc.), a more detailed differentiation of the walrus population based on analysis of walrus takes has become possible. Our data on the age composition of the harvested male walruses (see ,Fig. 1) show that 6—11-year-old animals predominate (approximately 60%) at the Rudder grounds in August—September, whereas 11—19-year-olds comprise up to 73% of the animals on Wrangel

Is. (Blossom hauling-out grounds) during the same period. An interesting fact is that old males 21—37 years of age, which are hardly ever encountered on Wrangel Is., constitute up to 10% of the walruses at the Rudder grounds.

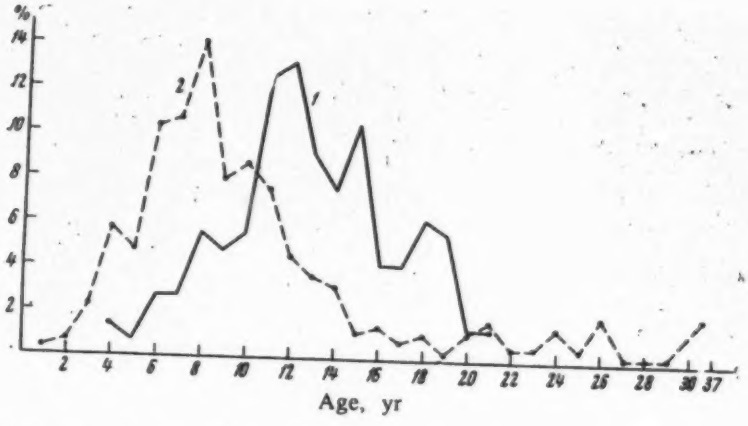

Fig. 1. Age composition of the takes of male walruses at the Blossom (1) and Rudder (2) hauling-out grounds

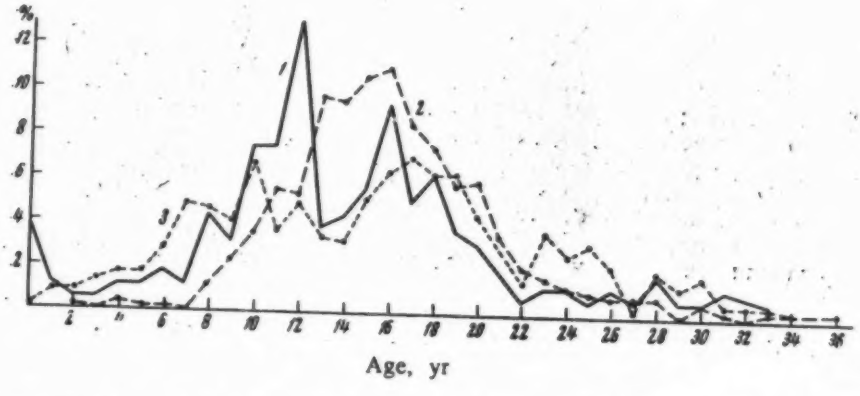

Fig. 2. Age composition of the takes of male walruses at ice rookeries in the Chukchi Sea (based on the data of V.I. Krylov, 1965): 1 - 1960, 2 - 1961, 3 - 1962

V.I. Krylov's data (1965) on the age composition of the walruses at the ice rookeries during 1960—1962 (Fig. 2) indicate that 11—20-year-old animals also predominate among the male walruses in the western part of the Chukchi Sea.

Since the data on the age differentation of male walruses are based on the analysis of walrus takes, one naturally wonders whether these

differences in the age composition of walruses from one area to the next are the result of the selectiveness of hunting. V.I. Krylov (1965) believes that the hunters of the Chukchi area strive to get the largest animals. As a result of this, fewer young animals and more adults are killed. Krylov also notes that old male and female walruses are only occasionally encountered among the animals killed in the northwestern parts of the Chukchi Sea.

There is no doubt that selectivity plays a certain role in the walrus hunt, but it is not likely to be the main cause of such a sharp difference in the age composition of the walrus takes from the Rudder grounds on the one hand, and those from the Blossom grounds and ice rookeries of the western part of the Chukchi Sea on the other. In our opinion, when the walruses are crowded together without any age differentiation, it is difficult for the hunter to shoot off animals of a specific age (e.g. only 6—10-year-olds or 11—13-year-olds), since the difference in their size is insignificant (10—30 cm). Meanwhile, 6—10-year-old walruses were harvested in larger numbers near the Rudder grounds, while 11—15-year-olds predominated in the takes from the Chukchi Sea. It is the animals of these age groups that account for the differences in the composition of the takes graphed in Fig. 1. The selectiveness of the hunt apparently consisted only in the fact that hardly any sexually immature animals (i.e. from 1 to 5—6 years of age) were killed by the hunters either in the western part of the Chukchi Sea or in the Rudder area.

It is appropriate to mention the comments of I. Veniaminov (after P.G. Nikulin, 1940) who, characterizing the summer distribution of walruses in Alaska, notes that the walruses landing in Alaska are essentially all males, juveniles and aged animals, never females. Furthermore, P.G. Nikulin (1940) is inclined to believe that these groups are formed by bachelor walruses which do not participate in mating.

Consequently, there probably is some differentiation of the Pacific walrus population during the summer—autumn period. Predominantly maturing males or young sexually mature walruses that are not quite physically mature (6—11 years old), as well as aged males 20 years of age and older, remain in the Anadyr Gulf (Rudder area and the Meyechken spit) and apparently along the Alaskan coast for the summer. A few sexually immature walruses (3—5 years old) remain with them. The

females, physically mature males and sexually immature male and female walruses migrate to the western part of the Chukchi Sea (around Wrangel Is.). At the same time, adult males often form separate groups at the ice rookeries.

Data on the ratio of different age groups in various populations are scarce. K.K. Chapsky (1936) attempted to determine the annual increment in the Atlantic walrus population. He assumed that the sexually mature animals made up 50% of the total population, and that only one-half of the females bore pups annually (according to Chapsky, female walruses mature in the fourth—sixth year of life, and male walruses mature a year later). With these initial data, Chapsky determined that the annual number of offspring does not exceed 12.5%, and with non-breeders and natural mortality taken into account, not more than 10%.

S.Yu. Freiman (1940), on the basis of a study of a large group of Pacific walruses, quotes the ratio of age groups as 59% adults, 24% sexually immature individuals, and 17% juveniles. According to S.Yu. Freiman, sexual maturity sets in at the age of 3 year in female walruses, and 5—6 years in male walruses.

V.I. Krylov (1965) determined that the increment of the Pacific walrus stock amounted to not more than 6.3% of the total herd. The age—sex ratio in the mixed walrus rookeries (according to V.I. Krylov) was 71.1% sexually mature animals (36% females and 35.1% males) and 28.9% sexually immature walruses of both sexes. In his most recent paper (1967), V.I. Krylov presented new data on the increment of the walrus population, which was 11.2% of the total herd. At the same time, he indicated that the sexually mature part of the herd made up 70% of the animals with a 1:1 ratio of males and females.

According to V.I. Krylov (1967), sexual maturity in walruses sets in at the age of 7—9 years (mostly 8 years) in male walruses, and at the age of 6—8 years in female walruses (but the greater part of the females begins to breed at the age of 7). Only 35% of the sexually mature females bear pups annually.

According to the data of foreign authors, the number of offspring amounts to 11% (Scott et al., 1959) and 14% (Burns, 1965) in the Pacific walrus, and to 8% of the whole population in the Atlantic walrus

(Mansfield, 1959). According to Burns, about 47% of the sexually mature females breed annually (12% more than indicated by V.I. Krylov).

We have attempted to determine the number of offspring and recruitment of the sexually mature part of the Pacific walrus stock by plotting a population curve which, in turn, was based on the age composition of the walrus takes. As we have already noted, the male/female ratio in the walrus population is 1:1. Therefore, the type of the walrus population curve will not change if we plot a curve on the basis of the age composition of the males and females separately or together. In our samples, the age material pertained mostly to the males, and the structure of the population was plotted on the basis of this material. At first, we combined the data on the age composition of the walrus takes from the Anadyr Gulf and from the western part of the Chukchi Sea. Combined, this material allows us to establish the age-group ratio characteristic of the sexually mature part of the herd, or, in other words, the population curve for the sexually mature animals. Later, having used Burns' (1965) and Krylov's data (1967) on the annual number of pup-bearing females, we determined the number of offspring (15—17% of the total population). However, in walruses, as in other pinnipeds, the highest mortality is observed during the first year of life. For example, the natural mortality in the first year is over 50% in the hooded seal (Rassmusen, 1961), 40% in the fur seal (Severtsov, 1941), and an average 35% in the ringed seal (Fedoseyev, 1966).

The age of onset of sexual maturity in walruses, if we go by the averages based on Krylov and Burns' data, will be 5—8 years (mostly 6—7 years) for the female walruses, and 6—9 years for the males, i.e. almost the same as in the ringed seal (McLaren, 1958; Fedoseyev, 1964; Nazarenko, 1965). The maximum known age is 37—38 years for the walrus, 32 years for the ringed seal of the Sea of Okhotsk, and 41 years for the seal of the Canadian sector of the Arctic (McLaren, 1958). Apparently, the natural mortality of the walrus does not differ much from that of the ringed seal. Therefore, we have accepted the mortality of the walrus during its first year of life as equal to that of the ringed seal, i.e. 35%. This figure may be slightly overestimated for the walrus.

Knowing the number of offspring and the natural mortality in the first years of life, we determined the relative abundance of yearlings in the population. We later calculated the relative number of 2—7-year-olds, assuming that the population curve in the sexaully immature part of the walrus population is an exponential curve as in other long-lived species of mammals (Severtsov, 1941). The population curve of the sexually mature part of the walrus population was plotted on the basis of the average data on the age composition of the walrus takes. On the whole, the population curve for the present Pacific walrus population proved to be an exponential curve (Fig. 3, 1).

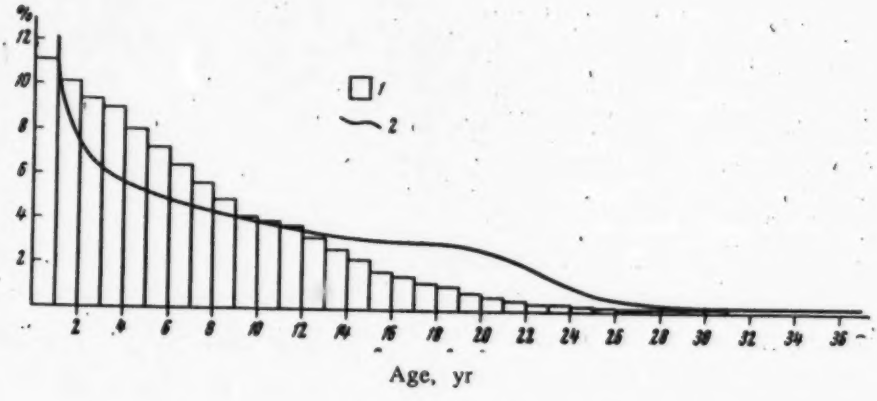

Fig. 3. Age structure of the Pacific walrus population
1 - present population, 2 - conjectural structure with no hunting

Under the effect of prolonged intensive exploitation of the walrus, the age structure of the walrus population has undergone significant rejuvenation, since predominantly adult animals were killed off. Because of this, the type of the population curve has changed considerably. In the absence of hunting, or with nonselective hunting of the walrus, the population curve for the walrus is apparently of the intermediate type[1] (Fig. 3, 2). The difference between the exponential curve and the intermediate curve lies in the fact that the natural decrease in the sexually

[1]We haved used S.A. Severtsov's terminology (1941) for the walrus population curves. He described three main types of curves for mammals and a number of other animals: the exponential curve (curve of the exponential function), the logistic or S-shaped curve, and the intermediate curve which lies between the two previous types.

mature part of the herd by the intermediate type of curve progresses much more slowly than in the sexually immature part of the population. Because of this, the relative abundance of sexually mature animals in the herd is greater. With the exponential curve, there is a certain relative increase in the number of sexually immature animals, which alters the ratio.

One should not assume that the ratio of individual generations in the herd will always give the correct population curve of this or that type, since the size of individual generations, though relatively stable over a long period, cannot be absolutely invariable. Therefore, the types of population curves (age structure) presented in Fig. 3 characterize the mean age composition of the population for a given period, not for any year as a whole.

In the present walrus population, the recruitment, which is calculated by the number of newborn, amounts to 15—17% by our estimates, while the recruitment based on the number of yearlings averages 11% of the total population. The recruitment of the sexually mature part of the population does not exceed 9.0%, i.e. the relative recruitment of breeding females is approximately 4.5% of the total numbers of the population.

If we take the natural mortality and the number of animals killed by hunters into account, the actual increment of the herd will be substantially smaller than indicated by our recruitment figures. According to Burns (1965), the annual mortality of the walrus averages 12—13%. With this taken into account, the increment of the walrus population will not exceed 3%; if we take into account the number of animals killed by hunters, the total losses will apparently exceed the increment.

During 1957—1960, the Pacific walrus population was estimated at 50,000 head (Fedoseyev , 1962; Fay, 1957). According to Brooks and Burns (J.W. Brooks, 1963; J.J. Burns, 1965), the Pacific walrus population numbered 70,000—90,000 head. If we take 70,000 as the average number of walruses, the increment of the herd with natural mortality taken into account will be 2100—2800 head.

The average annual take by hunters is 2600 head (about 1100 in the territorial waters of the USSR, about 1500 off the coast of Alaska). In addition, up to 30% of the animals drown during the hunting season.

Therefore, the total removal from the herd during the hunting season amounts to at least 3000 head.

We can therefore say that the numbers of the Pacific walrus population are obviously continuing to decrease slightly.

Of course, we do not claim that our estimates are highly accurate, but nevertheless, they do indicate that the walrus stocks are dwindling. To get a more accurate estimate of their numbers, the walrus count should be repeated by aerial photographic survey within the next few years[2]. The data on natural mortality also require verification. The coefficients of natural mortality derived by American researchers are apparently overestimated, since they were calculated on the basis of the age data for a population highly rejuvenated by hunters. If we were to calculate the coefficient of natural mortality by the maximum age in the samples (F.I. Baranov's method modified by P.V. Tyurin, 1963), its value would probably not exceed 8—10% on the average (maximum age 40 years) for the walrus population. However, even this value of natural mortality cannot be accepted unconditionally, since the maximum age has also decreased under the influence of hunters. In addition to population surveys, we should continue to study the age structure of the walrus population; this would make it possible to obtain a well-founded calculation of the increment and losses in the herd.

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[2]The first aerial photographic survey of walruses was carried out in 1960 (Fedoseyev, 1962)

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